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(54) Title: Method for Rigidly Solidifying Solid Powdered Particles Applied During Endothermic Reaction and Exothermic Reaction

Abstract:

First, the state of a compound during its reaction may be various, including a liquid, a gas, a solid (such as powdered particles), a mixture, or a colloid material. The present invention relates to a method useful in a reaction process involving a solid used in an endothermic or exothermic reaction, said method comprising 1) uniting, rigidifying, and three-dimensionalizing solid particle reactants or allowing reactants to be reacted step by step or reacting the reactants slowly and gradually such that they are not reacted at once. In this way, the reaction rate can be controlled by changing the surface area and the density of the solid during the reaction between the solid with a liquid, solution, colloid solution, etc. In the case where the rate of the reaction is fast and a gas is generated as a product of the chemical reaction, the structure of the reactor can be broken. In order to avoid this problem, a reactor should be modified, or a device capable of enduring pressure from a gas should be installed, which incurs more manufacturing costs. However, by uniting and rigidifying and three-dimensionalizing particulate solid reactants, or by applying the method described in Item 1) above, the rate of the reaction between solid compounds and a compound such as a liquid, solution, colloid solution, etc. can be controlled, which can advantageously simplify the structure of a reactor and save on manufacturing costs.

Second, by using the above-described method in a chemical reaction, which can be an endothermic reaction or an exothermic reaction, the structure of a reactor can be simplified as shown in this specification.

Specification

Detailed Description of the Invention

Purpose of the Invention

Technical Field of the Invention and the Prior Art

Reactants and a device suitable therefor are required to conduct a chemical reaction. There can be various reactants and reactors according to reaction conditions, and their structures may differ according to their respective use. The present invention is to provide a method in which solid reactants in the form of powdered particles is three-dimensionalized and then used in a reaction, or a reaction according to the method described in 1) of the Abstract is used. In such case, if the structure shown in Figure 1 is made and used, due to the reaction method (i.e., rigidly three-dimensionalizing the solid reactants in the form of powdered particles, and the method described in 1) of the Abstract), along with the simplicity of the shown structure, economic efficiency and ease in use would be provided. The term "powdered particles" refers to solid particles with a maximum length of less than 1 mm when placed on a flat surface. The term "rigidly three-dimensionalized solid compounds" refers to three-dimensionalized (or volumized) solids with a maximum length of 1 mm or more when placed on a flat surface, and more broadly, covers the case where some powdered particles are separated off from the three-dimensionalized solids, while the powdered particles have a weight less than that of the three-dimensionalized solids. Second, when a chemical reaction is conducted, a reactant and a product should be present. In the case where the reaction product is a gas and a liquid, a reactor, if sealed up, can be affected by pressure from the gas. The reactor can be broken if it cannot endure the pressure of the gas. In order to prevent a reactor from being broken due to a reaction product, the reactor should be manufactured such that it can endure the pressure of gas generated as a reaction product, which would excessively increase the cost of manufacturing the equipment. In other words, it would not be economical. In the case of conducting a reaction while discharging the gas generated from the reaction, the rate (amount) of the generated reaction product compared with the rate (amount) of the discharged gas becomes important. If the amount of the discharged gas is greater than that of the generated gas, the reactor can be protected from the pressure of the gas. In a reverse case, however, it is difficult to protect the reactor. Further, this problem can get worse when the reaction instantly occurs at room temperature and room pressure. In such a case, the present invention is configured to reduce the reaction rate by rigidly solidifying the reactants and using the method described in 1) of the Abstract, thereby lowering the pressure of the generated gas and preventing the foam-rising phenomenon that occurs after an instantly occurring reaction. In addition, the present invention provides a reactor having a simple structure that is suitable for such a method.

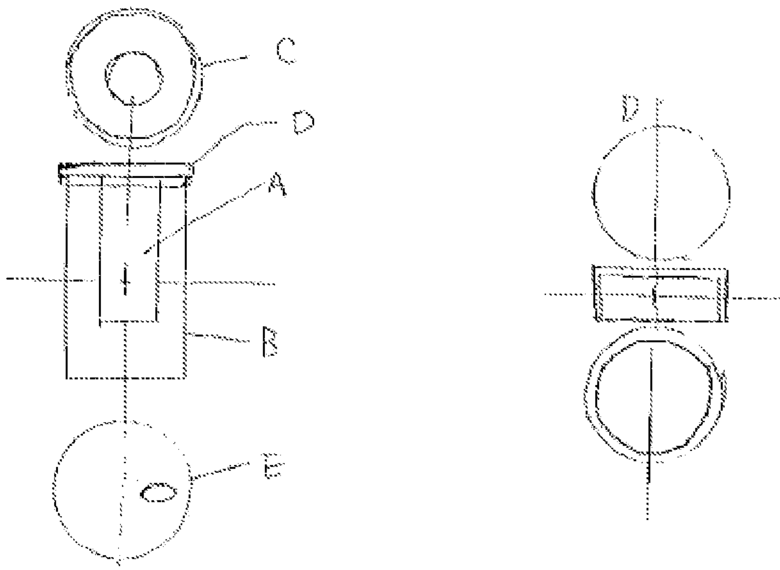

Figure 1. The structure of the reactor

First, the present invention can appropriately control the reaction rate by rigidly three-dimensionalizing the reactants and using the method described in 1) of the Abstract in the reaction. Second, due to the above, the present invention can simplify the structure of the reactor, thereby protecting the reactor from gas pressure or air bubbles or foam generated after the reaction; ensuring the user's safety and the economical manufacture of the reactor structure; and facilitating an exothermal and an endothermal reaction.

Generally, the reaction rate is crucial in a chemical reaction. The rate of a chemical reaction is affected by various factors, such as temperature, pressure, concentration, and catalysts. In the past, reaction rate was mostly controlled by controlling said physical amounts. However, in the method of the present invention, the shape of the reactants is of interest. Although a reaction can proceed regardless of the form of the reactants, i.e., particles or a hard solid lump, the reaction rate may vary. In particular, in the case where a gas and a liquid are generated as a reaction product, foam rises upward and high due to the generated gas within the reactor. If the height of the reactor is low, the foam will rise high enough to overflow. In such a case, conventional technology has tried to control the height of the rising foam by appropriately controlling the rate by changing the catalyst or a reaction factor (such as temperature, pressure, and concentration). However, the present invention advantageously controls the reaction rate by changing the shape of the reactants without considering factors such as temperature, pressure, concentration, and catalysts. Thus, the present invention can be applied in cooling or heating a surrounding beverage via a chemical reaction, such as an exothermic or endothermic reaction, using the method of rigidly solidifying the powdered particles and the method described in 1) of the Abstract. Further, the most simple and suitable structure of a reaction container is shown in Figure 1.

Technical Subjects to be Achieved

In the case where the reaction rate is controlled by controlling factors such as temperature, pressure, concentration, and catalysts, additional costs are incurred in satisfying said reaction conditions. However, the present invention simply changes the shape of reactants (by three-dimensionalizing the powdered particles into rigid solids). Thus, the present invention can reduce manufacturing costs and simplify the structure of a reactor.

Constitution and Function of the Invention

The present invention is directed to a method for conducting a reaction and controlling the reaction rate in an exothermal or endothermal reaction by rigidly and three-dimensionally solidifying the reactants in the form of powdered particles and using the method described in 1) of the Abstract. Figure 1 shows the structure of a reactor suitable for such a reaction. By rigidly and three-dimensionally solidifying the reactants in the form of powdered particles or using the method described in 1) of the Abstract, the present invention can advantageously reduce the reaction rate and the pressure of instantly generated gas. In this manner, the sudden foam-rising phenomenon caused by pressure from the instantly generated gas within a reactor can be controlled. When compared to the solids of powdered particles, the rigidly three-dimensionalized solids or the method described in 1) of the Abstract has a smaller surface area and a smaller frequency of collisions between the particles, which influences the reaction rate. In the structure shown in Figure 1, a reactant in the form of liquid or solution or colloid solution is fed into A and water or a beverage or an alcoholic liquor is fed into B. By feeding a rigidly solidified reactant or using the method described in 1) of the Abstract, a gas is generated and the water or beverage gains or loses heat. In such a case, the generated gas is discharged into the air after the reaction such that the container is not affected by the pressure of the gas. That is, the reaction is conducted in atmospheric pressure. Further, in the reactor structure, rigidly three-dimensionalized solids that participate in the reaction are fed into A, into which a liquid can then be poured. A beverage, alcoholic liquor, water, etc. are fed into B. D is the lid. The lid and A are separated by a thin film disposed therebetween. An opening measure for providing the beverage therethrough after initiating the reaction is installed in the lower part. A method for initiating the reaction is to add one of the reactants from the exterior into A in which other reactants are already included. By doing so, a reaction occurs and influences the surrounding beverage. After completion of the reaction, a solid or solution remains within A of the reactor. In such a case, products within the reactor can be discarded in a safe place or can be capped by using the D.

Examples

A device was prepared as shown in Figure 1, in which water or a beverage was fed into B and a reactant in the form of a liquid or solution or a colloid solution was fed into A. Then, a given amount of powdered particles were fed into container A at room temperature and

room pressure. A gas was generated, thus creating foam that overflowed. This is because the reaction proceeded quickly and an excessive amount of gas was generated. For this reason, the same amount of powdered particles which were used in the above were rigidly solidified and then fed. As a result, the height of the foaming was lowered by 1/10 when compared with that of the earlier generated foam. The three-dimensionalized solids initially sank to the bottom of container A but rose upward as its size became smaller in the process of the reaction. If a great amount of foaming rises upward upon feeding the powdered particles, the size of the reactor should also be increased, which would incur additional manufacturing costs. However, by using the three-dimensionalized solids or the method described in 1) of the Abstract, not that much foam is generated and the size of the reactor can be reduced. From the experimental results, we found that, in the case where the reaction product is a gas and a liquid or foam, the amount of foam, which is instantly generated due to gas generated after the reaction, can be reduced by using the rigidly three-dimensionalized solids rather than the powdered particles. Further, we also found that it is advantageous in terms of reducing the size of the reactor.

As a working example of an exothermic reaction, 50 g of sodium hydroxide powder was reacted with 100 ml of 20% solution of acetic acid and heat was generated with a great amount of initial foaming. For this reason, the reaction was conducted using rigidly three-dimensionalized sodium hydroxide. As a result, the amount of heat generated with initial foaming was about 1/5 the amount of the earlier generated foam. However, since this is an exothermic reaction, only a solid mass remained after the final reaction. Thus, the liquid reaction product evaporated.

As a working example of an endothermic reaction, 50 g citric acid powder and 50 g sodium bicarbonate powder were fed into 100 ml of water. Then radical pressure and foam were generated. For this reason, the mixture of 50 g of citric acid and 50 g of sodium bicarbonate were three-dimensionalized and fed into 100 ml of water. The reaction then proceeded slowly without generating radical pressure and only about 1/20 of the previously generated foam. When lid D of the container was closed concurrent to the initiation of the reaction, it opened after about 1-3 seconds when the powders were used. However, the same phenomena occurred after about 7-10 seconds when the rigidly three-dimensionalized mixed powders were used. Further, in the case of using powders, the container with a valve and an outlet of a porous material was broken. However, in the case of using the rigidly three-dimensionalized solid compounds, since the gas was generated slowly, the container did not break. In other words, since the amount of gas generated after the reaction is similar to the amount of discharged gas, the container is not greatly affected by the pressure of the gas.

Effect of the Present Invention

Generally, the present invention can reduce the reaction rate in an endothermic or exothermic chemical reaction wherein an amount of heat is released to or absorbed from a nearby substance, more specifically, an amount of heat is added to or removed from a

nearby beverage, water, alcoholic liquor, etc. by three-dimensionalizing the solid reactant(s) or using the method described in 1) of the Abstract. With this feature, a reaction can be easily conducted even in a small container; the costs for manufacturing a reactor can be reduced; and advantages in terms of safety and efficiency can be achieved. Further, the structure to which the present invention is applied can be simplified, and thus its manufacturing costs can be reduced. Further, the risks caused by careless use can be avoided by configuring the lid of a reaction container such that it is opened during a reaction but closed after the reaction.

(57) Claims:

1. A method for controlling the reaction rate in an endothermic or exothermic reaction between a liquid (one or more compounds such as a solution or a colloid solution) and a solid (one or more compounds) by rigidly three-dimensionalizing powdered solids to change their density (a degree of cohesion) and reaction surface area (three-dimensional model) and using them in the reaction.

2. A method for conducting a reaction by using the rigidly three-dimensionalized solids prepared by the method of Claim 1 in combination with a model having the structure shown in Figure 1 in an endothermic reaction or exothermic reaction, and a method according to item 1) of the Abstract.

3. A method for conducting a reaction by feeding the rigidly three-dimensionalized solid materials prepared by the method of Claim 1 from the exterior into a reactor, and a method for initiating a reaction by removing a film provided within the reactor.